



U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

3.7.4 SEISMIC INSTRUMENTATION

REVIEW RESPONSIBILITIES

Primary - Structural Engineering Branch (SEB)

Secondary - None

I. AREAS OF REVIEW

The following areas related to the seismic instrumentation program are reviewed:

1. Comparison with Regulatory Guide 1.12

A comparison of the proposed seismic instrumentation with the seismic instrumentation guidelines of Regulatory Guide 1.12 (Ref. 4) is made. In addition, the bases for elements of the program that differ from Regulatory Guide 1.12 are reviewed.

2. Location and Description of Instrumentation

The locations for the installation of seismic instrumentation such as tri-axial peak accelerographs, triaxial time history accelerographs, and triaxial response spectrum recorders that will be installed in selected Category I structures and components are reviewed. The bases for selection of the instrumentation and the locations and a discussion of the extent to which the seismic instrumentation will be employed to verify the seismic analyses following an earthquake are reviewed.

3. Control Room Operator Notification

The procedures that will be followed to inform the control room operator of the peak acceleration level and the input response spectra values shortly after occurrence of an earthquake are reviewed. Also reviewed are the bases for establishing predetermined values for activating the readout of the seismic instrumentation to the control room operator.

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USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

4. Comparison of Measured and Predicted Responses

The criteria and procedures that will be used to compare measured responses of Category I structures and selected components in the event of an earthquake with the results of the seismic system and subsystem analyses are reviewed.

5. Inservice Surveillance

The requirements for inservice inspection, testing and calibration as pertaining to operability and reliability are reviewed.

II. ACCEPTANCE CRITERIA

The acceptance criteria for the areas of review described in subsection I of this SRP section are given below. Any other seismic instrumentation program which can be justified to be equivalent to the acceptance criteria may be used. SEB accepts the seismic instrumentation system if the relevant requirements of General Design Criterion 2 (Ref. 2), 10 CFR Part 100, Appendix A (Ref. 3), and 10 CFR Part 50, § 50.55a (Ref. 1), as they relate to the capabilities and performance of the instruments to adequately measure the effects of earthquakes are met. Specific criteria necessary to meet the requirements of GDC 2, 10 CFR Part 100, Appendix A, and 10 CFR Part 50, § 50.55a, are as follows:

The instrumentation used for the measurements should be capable of recording the effects produced by the most severe earthquakes that have been historically reported for the site and surrounding area with sufficient margin for the limited accuracy, quantity and period of time in which historical data has been accumulated.

It is required in 10 CFR Part 100, Appendix A, that suitable instrumentation shall be provided so that the seismic response of nuclear plant features important to safety can be determined promptly to permit comparison of such response with that used as the design basis.

1. Comparison with Regulatory Guide 1.12

The seismic instrumentation program is considered to be acceptable if it is in accordance with Regulatory Guide 1.12 (see also Table 3.7.4-1). This guide recommends provision of a triaxial time history accelerograph and a triaxial response spectrum recorder to measure the input time history and response spectra directly. Additional time history accelerographs, response spectrum recorders, peak accelerographs, and seismic switches are recommended to measure the responses of structures, equipment, and components at selected locations. The bases for elements of the proposed seismic instrumentation program that differ from Regulatory Guide 1.12 must be provided.

2. Location and Description of Instrumentation

For the construction permit review there should be a commitment by the applicant to provide the following instruments at the given locations:

- a. A triaxial time history accelerograph in the free field or at the containment foundation, with readout in the control room.
- b. A seismic switch on the containment foundation, with readout in the control room.
- c. A triaxial response spectrum recorder on the containment foundation, with readout in the control room.

In addition, a commitment to provide the recommended additional instrumentation at the various response locations should be made without providing details of actual locations.

For the operating license review, a detailed seismic instrumentation plan including details of the locations, mounting and descriptions of the instrumentation should be provided. To be acceptable, the remaining instrumentation locations are related to the locations of the output vibratory motions used in the seismic design. Typical general locations are:

- a. Containment structure or reactor building.
- b. Reactor piping.
- c. Reactor equipment.
- d. Other Category I structures, equipment, and piping.

Instrumentation should be provided depending upon the plant safe shutdown earthquake acceleration as given in Regulatory Guide 1.12. The specific locations are determined by the plant designer so as to obtain the most pertinent information. A possible approach to the specification of the seismic instrumentation system is given in Regulatory Guide 1.12. Other desirable combinations of instruments which may prove to be as useful as the instrumentation plan outlined in the guide may be utilized.

The criteria for selection of Category I structures, components, and equipment to be instrumented and the location of instrumentation, as well as the extent to which this instrumentation is employed to verify the seismic analyses following an earthquake, should be specified. The criteria will be reviewed on a case-by-case basis.

3. Control Room Operator Notification

To be acceptable, the seismic switch located at the foundation of the containment should be connected to event indicators that are located in the control room, so that a signal is given when the preset threshold level (OBE acceleration level) resulting from the earthquake is exceeded. Also both audio and visual signals should be provided to the control room operators in the event of an earthquake.

In addition, the triaxial time history accelerograph located in the containment foundation or in the free field should be connected to the control room, so that peak acceleration level experienced in the basement of the reactor containment structure or in the free field is indicated to the control room operator. The response spectrum recorder in the reactor containment foundation or in the free field is also connected to the control room

to indicate if the design response spectra values for discrete frequencies are exceeded during an earthquake.

4. Comparison of Measured and Predicted Responses

In the event of an earthquake, the control room operator should be immediately informed through the event indicators. If the instrumentation shows that the peak acceleration or the response spectra experienced at the foundation of the containment building or in the free field exceed the OBE acceleration level or response spectra, the plant should be shut down (Ref. 3) pending permission to resume operations. To help predict the capability of the plant for resuming operations, field inspection of safety-related items should be implemented and the measured responses from both the peak-recording and strong motion accelerographs should be compared with those assumed in the design.

The procedures for comparison of measured and predicted responses are acceptable if a commitment is made to provide detailed comparisons, as outlined below, between measured seismic responses of Category I structures and equipment with calculated responses determined from dynamic analysis. First, the time history records are digitized and corrected for time signal variations and baseline variations. The time history records from the triaxial sensors located in the free field or at the foundation of the containment building are used to calculate response spectra at appropriate critical damping values. The response spectra thus obtained, or the response spectra from the response spectrum recorder, are compared with the design response spectra. In addition, the time history records from the free field triaxial sensor are used as input ground motion for the reactor building dynamic model, including soil where applicable. Amplified response spectra are then calculated at the locations of the other sensors in the reactor building for comparison and correlation with the response spectra directly measured. Structural responses and amplified response spectra are calculated using the free field time history records with the dynamic model for comparison with the original design and analysis parameters. This comparison permits evaluation of seismic effects on structures and equipment and forms the basis for remodeling, detailed analyses, and physical inspection.

5. Inservice Surveillance

Each of the seismic instruments shall be demonstrated operable by the performance of the channel check, channel calibration, and channel functional test operations at the intervals specified in Table 3.7.4-2.

III. REVIEW PROCEDURES

For each area of review, the following review procedure is followed. The reviewer will select and emphasize material from the procedures given below, as may be appropriate for a particular case.

1. Comparison with Regulatory Guide 1.12

The seismic instrumentation program is checked to assure that the instrumentation is in accordance with the guidelines of Regulatory Guide 1.12.

Any differences between the proposed and the guide seismic instrumentation, which have not been adequately justified, are identified and the applicant is informed of the need for additional technical justification.

2. Location and Description of Instrumentation

At the operating license stage, the locations and descriptions of the seismic instrumentation are reviewed to determine that these are in accordance with the acceptance criteria of subsection II.2 of this SRP section. If the instrumentation provided is judged to be insufficient, the need for additional instrumentation is transmitted to the applicant.

3. Control Room Operator Notification

The seismic instrumentation is checked to verify that the seismic switch located at the foundation of the containment structure or in the free field is connected to event indicators that are located in the control room, so that a signal is given when the preset threshold level is exceeded. If there is no provision for both audio and visual signals in the applicant's seismic instrumentation plan, the applicant is so informed with a request for compliance.

4. Comparison of Measured and Predicted Responses

The criteria and procedures that will be used to compare measured responses of Category I structures and selected components in the event of an earthquake with the results of the seismic system and subsystem analyses are checked to verify that sufficient information as specified in subsection II.4 of this SRP section is included. Any deficiency in the required information is identified and the applicant is requested to provide further information.

5. Inservice Surveillance

The inservice inspection program described by the applicant is reviewed to assure that the acceptance criteria of subsection II.5 of this SRP section are met.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and his review supports conclusions of the following type, to be included in the staff's safety evaluation report:

The staff concludes that the seismic instrumentation system provided for the plant is acceptable and meets the requirements of General Design Criterion 2, 10 CFR Part 100, Appendix A and 10 CFR Part 50, § 50.55a. This conclusion is based on the following:

The applicant has met the requirements of 10 CFR Part 100, Appendix A by providing the instrumentation that is capable of measuring the effects of an earthquake which meets the requirements of GDC 2. The applicant has met the requirements of 10 CFR Part 50, § 50.55a by providing the inservice inspection program that will verify operability by performing channel

checks, calibrations, and functional tests at acceptable intervals. In addition, the installation of the specified seismic instrumentation in the reactor containment structure and at other Category I structures, systems, and components constitutes an acceptable program to record data on seismic ground motion as well as data on the frequency and amplitude relationship of the seismic response of major structures and systems. A prompt readout of pertinent data at the control room can be expected to yield sufficient information to guide the operator on a timely basis for the purpose of evaluating the seismic response in the event of an earthquake. Data obtained from such installed seismic instrumentation will be sufficient to determine that the seismic analysis assumptions and the analytical model used for the design of the plant are adequate and that allowable stresses are not exceeded under conditions where continuity of operation is intended. Provision of such seismic instrumentation complies with Regulatory Guide 1.12.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

VI. REFERENCES

1. 10 CFR Part 50, § 50.55a "Codes and Standards."
2. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants."
3. 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants."
4. Regulatory Guide 1.12, "Instrumentation for Earthquakes."

TABLE 3.7.4-1 SEISMIC INSTRUMENTATION REQUIREMENTS

Instrumentation		Triaxial Time-History Accelerograph		Triaxial Response Spectrum Recorder		Triaxial Peak Accelerograph		Seismic Switch	
Location	SSE	0.3 g or less	over 0.3 g	0.3 g or less	over 0.3 g	0.3 g or less	over 0.3 g	0.3 g or less	over 0.3 g
I. Free Field		1*#	1*#						
II. Inside Containment									
Basement		1*	1*	1*	1*			1*	1*
At Elevation		1	1						
Reactor Equip. Sup.				}1	}1				}1*
Reactor Piping Sup.									
Reactor Equipment						1	1		
Reactor Piping						1	1		
III. Outside Containment									
Cat. I Structure			1	1	1				
Cat. I Equip. Sup.					1				
Cat. I Piping Sup.				}1	1				
Cat. I Equipment							1		
Cat. I Piping						}1	1		

*Control room readout.

#May be omitted if soil-structure interaction is negligible.

}Denotes either of the two locations.

TABLE 3.7.4-2

SEISMIC MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

<u>INSTRUMENT</u>	<u>CHANNEL CHECK</u>	<u>CHANNEL CALIBRATION</u>	<u>CHANNEL FUNCTIONAL TEST</u>
1. Triaxial Time-History Accelerographs	M	R	SA
2. Triaxial Peak Accelerographs	NA	R	NA
3. Triaxial Seismic Switches	M	R	SA
4. Triaxial Response-Spectrum Recorders	M	R	SA

Legend:

M = Monthly

R = Refueling

SA = Once per 18 months

NA = Not Applicable